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EDITORIAL

In view of the importance and necessity of geological knowledge; and with an aim to support the developmental activities of the nation by way of the achievements through geology and to further the science of geology at the national level, the Nepal Geological Society was founded in 1980.

The main objectives of the society are to develop the science of geology for national development, to protect and promote the interest of geologists, and help to maintain the highest professional standard among the members. Toward the achievement of the above aims, the society will mainly work to promote the study and research related to the geology of Nepal; publish journals and memoirs; organise seminars, conferences workshops, lectures and exhibitions; and develop close relations with related national and international organizations.

The total number of members of the society to date (25th August, 1982) is 103 among which 22 are life members. The membership is subject to the conditions specified in the constitution of the society and is open to all, irrespective of nationality. The society also aims at bringing together into one fold, particularly those who are engaged in, or who take interest in, geological research in and around the Himalaya.

In accordance with the above aims, the Society has been publishing a six - monthly journal (Journal of Nepal Geological Society). The society is happy to inform you that the two issues of the journal (Vol. 1, No. 1 & 2), have already been published and the third issue (Vol. 2, No. 1) will be out of the press very soon. Here, we would also like to request all our members and contributors to send research papers well in advance for the later issues which will greatly help us to bring out the journal timely.

The partial financial support extended by National Council for Science and Technology, HMG, Kirtipur was crucial for the publication of the second issue of the journal (Vol. 1, No. 2) and is thankfully acknowledged.

To acquaint our society members with the activities of the society as well as to make people well informed about the importance and contributions of geological scince in the national development, the society has also been publishing a six - monthly News Bulletin. The second issue (Vol. 1, No. 2) of the bulletin is in your hand. Due to various practical difficulties, the publication of this issue was late. The editorial board very much regrets for it. We have tried to make the issue more informative and interesting both for members as well as for our general readers.

Your valuable suggestions towards the improvement of our publications will be highly appreciated.

Nepal-The Himalayan Desert of Tomorrow

-Dr. B. N. Upreti*

The Reality

Whether we believe or not, nearly after two decades from now, we will be living in a country of mountain desert - a country with red-brown rocky hills having no soil, no vegetation and no agriculture. It is a stark reality and certainly horrible to think of. But perhaps there is no alternative to it and most of us are sure to experience those coming days in our own life time. If one likes to imagine how the future desert Nepal will look like, may take the examples of the hills of Afghanistan, Iran and further west. The view that Nepal is being converted into a desert land is an unanimous voice of many scientists.. Unfortunately, this alarming voice has not yet been taken seriously in our country.

The Deforestation

It is well known how we are rapidly converting our beautiful country into a desert by massive deforestation. The older generation has seen with their own eyes the thick jungles all over the hills and Terai just two to three decades ago - the jungles so difficult to infiltrate and inhabitated by varieties of wild animals. Where are those jungles now ? Travelling by air if one cares to see our hills keenly, now what is left is the clusters of houses in the brown-red background with practically no vegetation. Terai, on the other hand, till very recently was thickly forested. It is only within last one or two decades that it is almost completely shaved off. Now the remnants of those thick forests represented by few small green patches here and there speak of their glorious history.

The most notorious slogan "Nepal ko dhan hario ban" (forest is money) is the root cause of the present unfortunate situation. The authorities started clearing off the green belts of the country so ruthlessly and massivly that no considerations were given to the echological aspets. The

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deforestation in the hills was mainly due to increasing population, which demanded for more fuel, more construction materials and more agriculture land. In the absence of other substitutes and the lack of knowledge of its consequences, the jungles were cleared very fast. According to the estimate of 1975, nearly 30% of the total land of Nepal was covered by jungles. Even if we take this estimate as base, today's actual forest reserve can be well estimated to be far below 20%. This itself speaks of the alarming situation.

The Soil Erosion, Floods And Landslides

The few inches of top soil which we find on the immediate surface is our very life, and we are totally dependent on it for our existence. It requires tens of thousands of years for the formation of soil from the underlying rocks. Soil, in its true sense, is not merely the rock dust. It contains many other vital organic ingredients which make it fertile and to become capable to sustain the plant life. The layer of soil, as we all know, is a loose material and rests over the rocks that lie below. The stability of soil on the slopping ground of the hilly terrain is directly controlled by the vegetation, mainly the roots act as the binding force. Thus without vegetation, the soil layer is very unstable and even mild wind and rain can remove it from its base, leaving behind the barren rocks. The soils from the hills of Nepal in the absence of adequate vegetation are thus very easily being carried away by rains to the terai plains. The excess soil that is dumped in the plains, fills up the river channels causing the rivers to over flow and flooding the entire areas. It has been estimated that 1-2 mm of soil layer is being washed away by rains every year in Nepal (C. K. Sharma, 1974). It is also well known that the fertility in the hills have dropped down very sharply. It is mainly due to the massive deforestation with the consequence of continued washing away of the top fertile soil.

In the hills of Nepal, the occurrence of frequent landslides and the associated casulties are in increase. Many a times the entire village perishes under the debris of the rocks and soil. A village in the hill slopes has become very unsafe. Onset of every rainy season brings the fear and insecurity to all the hill people. The basic cause is again the deforestation. Today our hills are dotted with big landslide areas which were not so common any time before.

The conclusion that Nepal will be a desert in near future is not a probability, but a reality and we have already set our country for it. There is history to prove it. The Indus Civilization, the oldest and the finest civilization of mankind, was destroyed and leveled to the ground - the ultimate cause

was deforestation. The Sahara desert of Africa, is not old. Just a few generations ago, it was as green and fertile as it should have been. The massive deforestation changed the face of this region and this irreversible process of desertification converted the land with vast sea of sands. More nearer to us, the Rajasthan desert is much younger. The trace of Saraswati river, a famous and sacred river of Hindus, can very well be seen in the midst of the desert in satellite photograph. Here also the deforestation was the prime cause. Then, certainly, Nepal would not be the exception. Nature is impartial.

The Sign of Danger

The process of desertification is like slow poisioning. The slow but definite change that occur during the process is imperceptible at the earlier stage. But a more careful study of the overall abnormalities in the ecosystem will tell the story. Also as we are part of the ecosystem, the abnormalities which should immediately concern us, seems regular and thus a normal natural phenomenon.

Perhaps we have already started experiencing the effects of our henious acts. We have started feeling the serious ecological imbalance. The lost fertility of soil in the hills, the frequent landslides, the irregularities of rains causing famines in one part of the country and devastating floods in the other are the result of the same. The hills have become more drier than any time before. Small streams are becoming permanently dry. If one cares to keenly observe the hills of Far Western Nepal, it can be instantly realised that Nepal is truely becoming a desert. Agricultural production has dropped too sharply, hills are much drier compared to the other parts of the country and fire-wood is a luxury. It is too painful to find that even the culture is being changed with the changing enviornment. Scarcity of fire-wood is compelling them to bury the dead bodies instead of the traditional custom of burning them.

In the more advanced stage of desertification, when Nepal Himalaya becomes practically barren of vegetation, then we will not get sufficient rains too, resulting into drying up of more streams and rivers. Ultimately, it may lead to convert the entire land into a true mountain desert. The day is not very far.

A Bleak Hope

Let us not be carried away by the idea that by planting trees in a few square kilometers here and there, we can control the situation and save our country from disaster. The afforestation does help, no doubt, but to what extent in the way we are doing it ? By now how much afforestation have we done ? Only scattered patches in a

few square kilometers. Are we planting the same number of trees that we are cutting ? Certainly not. Then, where is the remedy ? The recent decision of HMG to stop export of timber is appreciable, but as in many other cases if it remained only on the paper, it is most unfortunate. If concrete measures are not taken, the deforestation will continue till the last tree is laid down. And thus, it is a time of emergency.

At this stage, the only effective way to save the country is to completely stop the deforestation for the coming three decades coupled with massive afforestation. Export of timber in any form should be absolutely banned. Internal demands of fire-wood and timber should be carefully managed. The possibility of alternative source of them can not be overlooked. There is no second way to control the situation. Today it is already very late and tomorrow it would be too late to do anything. At a further stage even if we mobilise all our resources, it would be just futile.

The Planning

Our sixth five year plan has not given due consideration on this vital national issue which is linked with the survival of Nepal and Nepalese people. There is no time to waste. A more realistic and positive approach to the tune of the urgency it requires, has to be made. The following basic measures are suggested here to control the situation :

1. With the help of most recent aerial photographs and landsat imageries (satellite photographs) the actual present extent of the jungles has to be identified. The land use map should be prepared in which, the forest areas, agriculture land etc have to be precisely delineated.

2. The new approach of HMG for mass participation in afforestation is good, but implimentation is more important. Provision of regular and adequate supply of saplings is most vital. Therefore, on priority basis sufficient numbers of centres for providing the saplings should be immediately established. Providing the technical advices is also equally important.

3. Afforestation should take into account the potentiality of planting medicinal and other economically important plants at different parts of the country. However, the local needs of the people should get no less priority.

4. As is well known, the problem of silting is a great threat to Nepal's large hydel and other irrigational projects. The life of such projects are drastically reduced due to silting. Kosi Dam can be taken as the glaring example. This factor is going to play worst role in the years to

come in Nepal due to increased rate of soil erosion. Therefore, before starting every new project, afforestation in the catchment area, sufficiently in advance, should be made mandatory. In this context, afforestation in Marshyngdi and Karnali catchment areas should be initiated as early as possible.

5. The fire-wood and fodder is the basic need of the rural population. In the name of saving the jungles, it is impractical to deny their basic needs unless the alternative is provided. In urban areas too, fire-wood is still the basic fuel in the kitchen. The government policy still reflects its view that electricity is a luxury. Supply of electricity at present is adequate due to recent completion of Kulekhani hydel project and future supply is also not going to be a problem, as many new projects are coming up. Therefore it is high time to start rural electrification in Nepal without delay. A cheap electric supply to the mass is definitely going to save a lot of wood. This is perhaps the ultimate solution to save the country from deforestation. Any amount of afforestation will not sustain the increasing demand of fuel with the sharply increasing population.

The first step in this direction is to cover all the urban areas (which are already under the network of electricity supply) by providing electricity at the cheapest rate. For example, Kathmandu alone may save a sizable amount of fire-wood by this process. Our planners may think rural electrification an unrealistic approach, but then there is no alternative to it. The only alternative at present is coal, but it is too costly for the general mass and requires a large amount of foreign currency.

6. Problem of landslide is another great threat to Nepal's ecosystem. Slope instability and related soil erosion are causing irreparable loss to life and land. To stop this phenomena requires an overall geological approach. After the identification of such areas with the help of aerial photographs and other aids, a realistic measures should be immediately taken. Engineering geology thus occupies the key position in this field.

7. Construction of road has also contributed to a great extent for landslides and soil erosion. Due geological considerations should be given before construction of roads and immediate measures should be taken for slope stability and soil erosion (including afforestation).

8. The prevailing practice of random

quarrying of stones at various places, particularly in Kathmandu, should be immediately stopped. Geological considerations and ecological factors are not taken in any of these quarries around Kathmandu. Examples of Thankot, Godavari and Halchok areas can be cited. It would not be more than ten years from now that we will find the entire northern slope of Chandragiri dotted with landslides and facing problem of massive soil erosion.

9. Out of all the above measures, the most important and effective way to save the country is to have mass participation. It is they, who are going to shoulder the burden of afforestation and preservation of the jungles. Therefore mass awareness on this problem is most vital. Effective role of mass media can not be overlooked here. It should reach to the people of every corner of the country that Nepal is becoming a desert which is an irreversible process and it is their own responsibility to save the country.

We have destroyed the very basic of life for our immediate benefit. If we do not correct it in time, let us imagine tomorrow's Nepal - with many times the population of today, with entire Himalaya deserted and terai devastated with floods and famines. Where are we going to go then ? Can we think of our own existence at that time ? These are the questions of life and death of Nepal and Nepalese people and time will answer these questions. However, in any case, we should not forget that future generation will never forgive us for this crime.

And some rin up hill and down dale
Knapping the chucky stanes to pieces
wi' hammers, like sae many
road makers run daft. They say
it is to see how the world was made.

-Sir Walter Scott

Development of Geology in Nepal

-Sangeeta Sigdel *

Geology has a tremendous role to play in the shaping of economy of any country, developed or underdeveloped. Particulary in developing countries like ours due attention to geology can greatly facilitate the development efforts, but its importance in economic upliftments generally, either underestimated or realized rather inadequately.

Historical Sketch

As far as the history of development of geology in Nepal is concerned, it dates back to 1847. It is reported that in 1847, a British scientist carried out some work of geological nature, but the details of which are not known. From 1875 onwards a number of European geologists, associated with the Geological Survey of India, has carried out geological work in persuance of their different assignment. They are Medlicott (1875), Mallet and Jones (1889), Oldham (1899, 1917 and 1920), Holland (1908), Reed (1908) and Diener (1912).

The establishment of the department of Irrigation and Geology in 1930 was a major landmark in the institutional effort toward the development of geology in the country. Yet another positive development was the inception of the Bureau of Mines in 1941. Geological work and the mineral resources exploration work being interrelated with each other, all geological works were entrusted to the bureau. Also, a number of foreign geologists continued to considerably contribute to the geology of Nepal. The contributions made by such eminent geologists as Bowman, Aduen, Ghosh, Heim and Gansser could not go unnoticed in the brief history of development of geology in Nepal.

The newly set up Bureau of Mines, entrusted with the twin tasks of mineral exploration as well as geological mapping of the whole country was confronted by paucity of skilled technicians. Thus the first major institutional effort toward mineral and geological development of the country

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was on the brink of suffering a severe setback. But the assistance received from the USA in the form of technical manpower, equipments and training facilities greatly helped to overcome these problems thus enhancing the performance capacity of the bureau to give a fillip to the effort directed at the development of mineral resources and geology. During 1950s an expert from the United Nations was deputed to help assess the country in its mineral wealth; and between 1961-66 some geological work, under an agreement, was also carried out by geologists from the Geological Survey of India.

In 1967, a seperate department of geology was established with a view to execute a systematic geological work geared to the development of mineral resources. With the establishment of the dapartment, development of geology was sought to accomplish in a specific and concerted manner so that various aspects of the geological study could be dealt with, hence mineral resources explored and developed. However, due to various practical difficulties, the department of geology was once again amalgated into the bureau of mines and the newly organized Department of Mines and Geology came into being in 1976.

Importance of Geology

Resource constraint being a major hurdle to Nepal's developmental efforts, dearth of physical & financial resources has severely handicapped the successful execution of the five periodic plans that have been implemented as yet. Against this background it is but natural to emphasize the need for due attention to the development of geology which makes possible the exploration of enormous resources hidden in the womb of this Himalayan part of the globe, there-by enriching the country with vast physical resources and, with the proper utilization of these, financial resource as well.

Country's industrial development and trade promotion are also certainly to go up once the hidden treasure is traced and uncarthed which is possible only when the field of geology is adequately heeded to, now that the erroneous impression of foreign geologists of the fifties that Nepal is barren of economic mineral deposits have been proved wrong. The heydays that the OPEC countries are presently enjoying (thanks to their petroleum reserve) and that a number of African & Latin American countries are making good of their vast mineral resources (thanks to the effort of geologists hired by the multinationals) are worth remembering here in that Nepal is also believed to have possessed abundant natural resources.

Experiences reveal that negligence of geology in course of building infrastructural

facilities for development such as road, hydel power etc. may more often than not cause catastrophic consequences. The failure to recognize the importance of engineering geology led to the many collapses of structures. Subsequent enquiries into the causes drew the conclusion that such disasters could have been averted.

Presently, the continued deforestation has been a chief concern to us, its repercussions have already begun surfacing in the form of soil erosion, landslides, floods, uneven rainfall, drought etc. The situation is bound to worsen in the time to come if a sound and effective forest policy with special emphasis on afforestation and tree preservation is not supported by an equally sound geological policy and programme.

The groundwater irrigation scheme presently accuring good results in the western Terai districts has shown that geology can contribute to the modernization of agriculture, the mainstay of the country's economy, by making available the crucially important irrigation facilities thus saving the agriculture from the wrath of the uncertain rain-God. Geohydrological investigations of the Terai belt have brought further promising pictures to the light in this regard, thus widening the scope and role of geology in the national economy.

Knowledge is power, but it is power for evil just as much as for good. It follows that, unless men increase in wisdom as much as in knowledge, increasing of knowledge will be increase of sorrow.

–Bertrand Russell

Phosphorite - A Fertilizer Raw Material

–R. P. Bashyal *

We all know that "Phosphorous" is an essential element of nutrition for the organism. It helps for the growth of plants and trees. Even the micro-organisms as bacterias need this element for their development. Besides that, phosphorous is also used in metallurgy and chemical industry. Phosphorous is not found in a native form but it always occurs as different minerals. The most common mineral is "Apatite" simple formula of which is $Ca_{10}(PO_4)_6F$. In this formula different elements may be replaced by (OH), CO_3, Cl. groups etc. Rocks containing calcium phosphate or other phosphate minerals is called "Phosphorite" or simply "Phosphate Rock".

Phosphorites occur either in sedimentary or in igneous rocks. Pure apatite is found in igneous rocks whereas a very complex phosphate mineral "Collophane" is found in sedimentary rocks like limestone, dolomite, black slate, chert, sandstone etc. Phosphate rocks are used primarily for the production of fertilizer of different kinds. More than 80% of the fertilizer raw material in the world is obtained from sedimentary phosphorites.

Phosphorite is being explored in Nepal since 1970 and it was reported from Dharan Barahakshetra area by an UN Expert. Prospecting works carried out by the then Nepal Geological Survey proved it an uneconomic deposit. The phosphorites contained less than 5% P_2O_5. Detailed investigation in this region by the author revealed the presence of Gondwana plant fossils (Permian age: 225-280 million years) and the volcanic rocks which were unfavorable for the rich accumulation of phosphates.

Now the search for phosphorites is being carried out by the Department of Mines and Geology. The stromatolitic (structures of micro-organism) phosphorites were reported for the first time by the author from Bailadi and Bajhang districts of Far Western Nepal.

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The stromatolities are presumed to be 900 to 1200 million years old. The phosphorite beds occur in Dhik Gad, Junkuna, Morgaon and Sanogaon of Baitadi district. From preliminary prospecting works, carried out in 1981/82 by the author, it is found that the phosphorite beds are up to 5m thick (minimum minable thickness is 1m) and contain 10% to 15% P_2O_5 in average (P_2O_5 content must be more than 18% for economic deposit).

The phosphorite mentioned above, can be considered uneconomic for the time being, due to the difficulty of benificiation as it is associated with dolomite mineral. But the present technology, which upgrades such phosphorites to 32% P_2O_5 containing concentrate, is being developed and it is in a semi-industrial scale in India. So the phosphorites of Far Western Nepal may also become economic in future.

Any body can become angry, that is easy. But to be angry with the right person, and to the right degree, and at the right time, and for the right purpose, and in the right way - that is not within the power of every body and is not easy.

खोलो फर्केन तर ढुङ्गोले बोल्यो

प्रकाशचन्द्र अधिकारी *

"खोलो फर्केन, ढुङ्गो बोल्दैन"। यहि हो हाम्रो वरिपरी हकनक्क फुलेको प्रकृति प्रतिको धारणा। ढुङ्गा-माटोले अर्थ बोल्न थालेका छैनन। हाडभाउ र सान गरेर बुझाउन सम्म पनि सक्दैनन। त्यति भए पनि प्रकृति आफ्नो पीरमर्का पोखीरहेको छ आफ्नै प्राकृतिक भाषामा। कस्तो रहेछ त त्यो भाषा ?

प्रत्येक जनभाषा मानव शरिर-रचनाले उपलब्ध गराएको प्राकृतिक स्वरहरूमिल बाँधिएको हुन्छ। त्यसैले प्रकृतिको पनि आफ्ना प्राकृतिक स्वरहरू छन। प्रकृतिका प्रत्येक रासायनिक अणुहरूले प्राकृतिक रूपमा उपलब्ध पदार्थको विविधताको ठहर गर्छ। ती सबै सैद्धान्तिक रूपले सम्भव रासायनिक अणुहरू प्रकृतिको प्राकृतिक स्वरहरू भए। उच्चारण गर्न सकिने सबै प्राकृतिक स्वरहरू कुनै पनि जनभाषाका प्रयोग गरिन्न वा ती प्राकृतिक स्वरहरू मध्येका जनभाषामा प्रयोग गरिने विशिष्ट स्वरहरू बाह्रखरिका स्वरहरू र तिनीहरूको संमिश्रणबाट उत्पन्न हुने बाह्रखरिका व्यञ्जनहरूमिल प्रत्येक जनभाषा बाँधिइनु पर्छ। रासायनिक अणुहरूको विशिष्ट नियम बद्धताको रूपमा देखा पर्ने सरल स्फटिक र तिनीहरूको संमिश्रणबाट उत्पन्न हुने मिश्रित स्फटिकलाई क्रमशः बाह्रखरिका स्वरहरू र व्यञ्जनहरूको रूपमा लिनु पर्छ। ज्यामितीक रूपले सम्भव बाह्रखरिका स्वरहरू प्रकृतिमा टाकटुक ४७ छन र बाह्रखरिका व्यञ्जनहरूको संख्या असिमित छ। यस सम्बन्धमा अध्ययनरत भू-विज्ञानलाई स्फटिक ज्यामिती (*Crystallography*) भन्दछन। यसरी नबोलने प्रकृतिको बाह्रखरीको ढुङ्गो लाग्यो।

बाह्रखरि आफै र तिनीहरूको संयोगबाट जनभाषाहरूमा शब्द रचना गरिन्छ। एउटा सरल स्फटिक, एउटा मिश्रित स्फटिक अथवा ती दुवैको परस्पर र आन्तरिक संयोगबाटनै प्रकृतिले पनि आफ्नो शब्द खनिजको रचनागर्छ। सिलिकन-डाई-अक्साइड जस्तो रासायनिक अणु बाह्रखरिको रूपमा प्रयोग भएर कयौं शब्दको रूपमा लेखिइन्छ। त्यस्तै प्रकृतिमा देखापरेका अरू शब्दहरू; नुन, सुन, अभ्रख इत्यादि भए। प्रकृतिमा आजसम्म पढन सकिएका शब्दहरू जम्मा जम्मी लगभग २००० छन। यस सम्बन्धमा अध्ययनरत भू-विज्ञानलाई खनिज विज्ञान (*Mineralogy*) भन्दछन। अब त प्रकृतिका शब्दहरू पनि फेलापरे। प्रत्येक शब्दको बेग्लै विशिष्ट अर्थ निस्के पनि तिनीहरूलाई मालामा चिटिक्क गुँथेर

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वाक्य रचना गर्न सकेमा त्यसको वैचारिक सौन्दर्य हुन्छ । वाक्य रचना सम्बन्धि नियमहरूको ज्ञानको अभावमा खनिजहरूको नियमबद्ध उपस्थिति शब्दहरूको निरर्थक थुप्रो मात्र हुन पुग्छ भने व्याकरणले ताछिएको शब्दहरूको भेला वाक्यले एउटा अभिव्यक्ति गर्छ । क्वार्ज, फेल्डस्पार र अभ्रख यी तिन शब्दहरू विशेष व्याकरण अन्तरगत एकै ठाउँमा फेला पर्दा एउटा वाक्य "ग्रानाइट" लेखिइन गयो । वाक्य ग्रानाइट एकथरिको ढुङ्गो अथवा शिला हो जस्ले आकृमा एउटो निश्चित अभिव्यक्ति बोकेको हुन्छ । ढुङ्गोको अनुहार देखे बित्तिकै, यस ढुङ्गो बनलाई आवश्यक भौतिक तथा रासायनिक परिस्थितिहरूको वाक्य फुटेर आउँछ । यस सम्बन्धमा अध्ययनरत भू-विज्ञानलाई शिला विज्ञान (*Petrology*) भन्ने नाम दिईएको छ । प्रकृतिका वाक्यहरू पनि फुटेर आईसके ।

वाक्यहरूको विभिन्न जमघटहरूले केरा केही अभिव्यक्ति दिन्छन । वाक्यहरूको एउटा निश्चित क्रमबद्धताले लेखकको मस्तिस्कमा उठिरहेको साहित्यिक महत्वको विचारको अभिव्यक्ति गर्छ । एउटा वाक्य ग्रेनाइट र अर्को खरिढुङ्गो लिएर हिजदा कल्पिमा तिन प्रकारका बेग्ला बेग्लै विचारहरू उत्पन्न हुन्छन । पहिलो, ग्रेनाइटको उत्पत्ति खरिढुङ्गो भन्दा अघि भयो, दोश्रो, त्यसको ठीक विपरित र तेश्रो हुन सक्छ दुवै संगसंगै बने । यी तिन प्रकारका विचार-हरूको आ-आफ्नै वैज्ञानिक र भू-आर्थिक महत्व हुन्छ । प्रकृतिमा लेखिएका यस्ता असंख्य वाक्यहरू मिलेर एउटा सिङ्गो साहित्यिक कृतिको सृजना हुन्छ । त्यस्ता कृतिहरूलाई भू-विज्ञानमा भौगर्भिक संरचना (*Geological Structure*) भन्ने चलन छ । प्रत्येक भौगोलिक एकाईहरू आफ्नो भौगर्भिक संरचना रूपि अभिव्यक्ति मार्फत आफ्नो बितेको इतिहासको ज्ञान दिई आफ्नो भविष्यतिर यसो चिहाउन मद्दत पुराउछन ।

भौगर्भिक संरचनाहरू त्यस्ता महाकाव्यका पात्रहरू हुन जस्को आफ्नो विशिष्ट चरित्र छन, आफ्नो बेग्लै इतिहास छन र भविष्यप्रतिको बेग्लै गणना छन । माथि उल्लेखित प्रश्नहरूसंग सम्बन्धित भू-विज्ञानलाई भौगर्भिक संरचनाको पदार्थको रासायनिक अध्ययन मात्रले नपुगेर दिक र काल जस्ता प्राकृतिक दर्शनका प्रश्नहरूको उत्तर खोतल्न बाध्य हुनुपर्छ । यस क्षेत्रलाई भू-विज्ञानका विभिन्न शाखाहरू सम्बन्धित छन, जस्लाई एकिकृत रूपमा "भू-रचना विज्ञान" (*Geotectonics*) भनिन्छन । विशिष्ट भू-संरचना जस्ता रोचक र प्रभावशाली पात्रहरूको आफ्नो सम्पर्कमे हामीलाई महाभारत झैं अति रोचक महाकाव्यको तिलस्मी संसारभित्र पुराइदिन्छ । हाम्रो हिमालयको महागाथामा हजारौं अर्जुनहरू र लाखौं कृष्णहरूले असंख्य महाभारत मच्चाई रहेका छन र असंख्य महाभारतहरूले भविष्य कुरिरहेका छन । यी महाभारतहरू पढन सक्ने चिलचा जस्ता आँखाहरूको आज खाँचो छ र तिनले हिमालयको गर्भमा लुकामारी खेलीरहेका अमूल्य निधिहरूको भेउ पाउनु परेको छ ।

ज्ञान मर्दछ हाँसेर रोई विज्ञान मर्दछ ।

—सम

Oil and Natural Gas Exploration in Nepal

-G. S. Thapa *

It is interesting to know that Department of Mines and Geology is actively engaged in the exploration activities of oil and natural gas in Nepal. In this context the Natural Gas Project of Kathmandu valley and the Petroleum Exploration Promotion Project in the Terai belt of the kingdom are noteworthy. These projects have top priority in the current fiscal year. Although it is too early to comment on the economic aspect of the oil and natural gas deposit in Nepal, considering the land-locked nature of the country which depends on imported oil, any effort in this direction is praiseworthy. As a matter of fact, such projects should have taken shape long ago. Still it is never too late.

Natural Gas Project of Kathmandu Valley

Natural gas deposit of Kathmandu valley is being investigated by the Department of Mines and Geology to assess the possibility of its commercial exploitation.

The surface and sub-surface geological data so far indicate that about 42 million cubic meter of natural gas (dissolved in water) occur at a depth ranging from 180m to 300m. below the surface, in the sand layers underlain by 180m thick carbonaceous clay. The gas field has an area of four square kilometers arond Teku - Tripureswar area. The total thickness of the gas reservoir is about 82m. This horizon is expected to extend vertically and laterally should further testing be done. The natural gas consists mainly of methane (14%) the calorific value of which is 7200 Kcal/Nm³ and can be used for domestic fuel. It is with this aim that the the Department of Mines and Geology is going to set up a model gas plat in order to study the consistence of the gas. Under this scheme two 300 meter test wells are to be drilled at Teku Dobhan and Teku Hospital. The available gas from these two

* Sr. Geologist, Department of Mines and Geology, Lainchaur, Kathmandu, Nepal.

wells and the one already existing at Tripureswor will be collected at central gas holder through the pipelines which will be supplied to the user (at the beginning only to the government offices situated around Teku – Tripureswor area) through the distribution pipeline. The model plant construction project is supposed to be completed within the current fiscal year 1982.83.

The Japanese Government is providing technical expertise and some equipment services to the project.

Petroleum Exploration Promotion Project

It is a pleasure to note that Nepal has entered inio petroleum exploration activities. Having completed the aeromagnetic survey in the country's Terai basin in 1980 with the IDA (International Development Association) finance, the Department of Mines and Geology is now carrying out reconaissance seismic survey of 800 line kilometer, in area of high magnetic anomalies. The main objective of the project is to further confirm the structures identified by the magnetic survey. These results will be made available to oil exploration companies in the hope of attracting them to undertake farther more sophisticated and costly exploration. The project is estimated to cost 10.9 million dollars out of which 9.2 million dollars credit is provided by IDA.

The project also envisages on the job training in petroleum geology and geophysics with a view to strengthennig technical capability of the project staff.

One of the functions of intelligence is to take account of the danger that come from trusting soley to the intelligence.

Oil and Natural Gas Exploration in Nepal

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SHORT COURSES

December 1982

FIRST INTERNATIONAL SHORT COURSE ON SMALL SCALE MINING, Bangalore. Five weeks including lectures, laboratory work, seminars and field tours. Limited number of scholarships and travel grants available to deserving candidates. Contact: Prof. C. Naganna, Director, School of Earth Sciences, Bangalore University, Jnana Bharati, Bangalore. 560 056. India.

January 31 - February 25, 1983

REMOTE SENSING: DIGITAL IMAGE PROCESSING (Flagstaff, Arizona, U. S. A.) Advanced training course for foreign nationals.

For Information: Training Section, Office of International Geology, U. S. Geological Survey, 917 National Center, Reston, Virginia 22092. U S. A.

UNESCO — SPONSORED TRAINING COURSES

(For some years now UNESCO has been sponsoring a series of courses for post-graduate training in earth scieces specifically for geologists from developing countries. Scholarships are available for many of these courses).

REMOTE SENSING APPLICATION (Enschede, The Netherlands): This course will update knowledge of developments in the application of remote sensing in geology, geomorphology, soil survey, terrain classification and water resources. Organized yearly (January-March) by the International Institute of Aerial Surveys and Earth Scinces (ITC). Certificate of attendance issued, Language: English.

For information and application: ITC Student Affairs office, P. O. Box 6, 7500 AA Enschede, The Netherlands.

MINERAL EXPLORATION (Leoben, Austria): The aim of this course is to provide specialized training in all aspects of mineral exploration. The following topics are included: trends of prospecting and exploration; photogeology and remote sensing; exploration, analytical, and data processing methods; unconventional production methods in mining; and mining financing and legislation. Diploma issued. Organized yearly (February 1 - June 30): next session 1983. Language: English.

For information: University for Mining and Metallurgy, Postgraduate Course on Mineral Exploration, Montanuniversitat, Leoben, A 8700, Austria.

PRINCIPLES AND METHODS OF ENGINEERING GEOLOGY (Budapest, Hungary); The Hungarian Geological Institute is offering a course aimed at both the theoretical and practical aspects of engineering geology mapping and applied engineering geo-

logy. Lectures will include rock and soil mechanics, engineering geological mapping, settlement development, foundation problems, open-cast and underground mining, and other aspects of applied engineering geology. Certificate issued. Course runs June 1 - August 31; next session 1983. Language: English.

For information and application: Hungarian Geological Institute, Nepstadion ut 14, P. O. Box 106, H 1142 Budapest, Hungary.

METHODS AND TECHNIQUES IN EXPLORATION GEOPHYSICS (Hyderabad, India): This course is primarily intended for in-service personnel associated with geological and geophysical exploration programs, including exploration geophysics, gravity magnetic, electrical and electro-magnetic, seismic and radiometric methods, and geological interpretation of geophysical data. Diploma awarded. Organized by National Geophysical Research Institute, this course runs yearly from November – December. Language: English.

For information and application: The Director, Regional Training Courses on Methods and Techniques in Geophysical Exploration, National Geophysical Research Institute, Hyderabad, 500 007 (A. P.) India. Copy to: UNESCO Regional Office for Science and Technology, 17 Jor Bagh, New Delhi 110003, India.

Forthcoming

INTERNATIONAL SEMINARS AND CONFERENCES

November 17-24, 1982

PHOSPHORITES, (Fifth International Field workshop and Seminar), Kunming China. (Wang Daxion, Secretary General, Organizing Committee of the Fifth International Field workshop and Siminar on Phosphorites, c/o Ministry of Geology, Beijing, China).

December 1-6, 1982

4th, INTERNATIONAL CONGRESS OF ENGINEERING GEOLOGY. New Delhi. International Association of Engineering Geology. Contact: G. Pant, Geological Survey of India. 47 - 48 Pragati Bhawan, Nehru Place. New Delhi 110019, India.

April 11-13, 1983

PROTEROZOIC-83, Lusaka. Pre- and Post-session excursions. Abstracts deadline: Oct. 1. Registration: Aug. 31. Data is from: The Organizing Secretary.

Proterozoic-83, Geological Society of Zambia, P. O. Box 50135, Lusaka. Zambia.

December, 1983

GROUNDWATER'83, (IAH Symposium), Sydney, Australia. (W. Williamson, Ibis House, 201/211 Miller St., P. O. Box 952, North Sydney, N. S. W. 2060, Australia).

March/April, 1984
GEOLOGY, MINERAL AND ENERGY RESOURCES OF SOUTHEAST ASIA, (GEOSEA V), Kuala Lumpur, Malaysia, (T. T. Khoo, Department of Geology, University of Malaya, Kuala Lumpur 22-11, Malaysia).

August 4-14, 1984
27th INTERNATIONAL GEOLOGICAL CONGRESS, Moscow, U.S.S.R. (N. A. Bogdanov, General Secretary, Organizing Committee of the 27th IGC, Staromonetny per. 22, Moscow 109180, U. S. S. R.)

(Courtesy: IUGS News magazine EPISODES and AGID News.)

Energy News

Import of Products/Crude in Nepal

Year	Product	Quantity (MT)	Year	Product	Quantity (MT)
1974	Gasoil	17939.450	1978	Gasoil	99435.269
	Kerosene	16996.720		Kerosene	42975.349
1975	Gasoil	17576.250	1979	Gasoil	62142.112
	Kerosene	59575.127		Kerosene	23215.643
1976	Gasoil	18383.632	1980	Gasoil	39606.238
	Kerosene	57708.983		Kerosene	75000.000
1977	Gasoil	17496.395	1981	Gasoil	87758.398
	Kerosene	38101.492		Kerosene	20871.551

(Courtesy: Nepal Oil Corporation)

Demand projection of Petroleum products for the sixth plan period (1980–85) of Nepal

Quantity in MT

	1980/81	1981/82	1982/83	1983/84	1984/85
	Quantity	Quantity	Quantity	Quantity	Quantity
Motor Spirits	8974	8500	8500	8500	8500
High Speed Diesel	47363	50000	50000	60600	66600
Kerosene	29392	34300	35000	37800	39700
Light Diesel Oil	8814	11200	15800	16100	16400
Furnace Oil	2863	3500	3600	3700	3800
Aviation Turbine Fuel	13002	15400	16200	17000	17900
Sub Total	110408	122900	135100	143700	152900
Lubricants/Greases	826	2200	2500	2700	2900
Jut Batching Oil	651	1500	1500	1500	1500
Asphalt	75	700	800	900	1000
Liquified Pet Gas	313	1200	1400	1600	1800
Sub Total	1865	5600	6200	6700	7200
Grand Total	112273	128400	141300	150400	160100

(Courtesy-Nepal Oil Corporation)

NGS Congratulates the SGC.

The Graduate and Post – Graduate students of the Department of Geology, Tribhuvan University, Kathmandu have established the Students Geological Club in May 1981. NGS expresses its best compliments.

भौगर्भिक पात्रो

मेघराज घिमाल *

हाम्रो वरिपरिको संसार प्रत्येक क्षण क्षणमा बदलिरहेछ । आज कतै सुनौला घाम घर-आँगनमा लागिरहेको छ भने हिजो कहीं कुमल्ल पानी परिरहेको थियो, भोलि नीलो आकाशमा सेता बादलहरू कालाबादल सक्छन् भने पर्सी कालो नीलो हुरीले हुङ्गा, माटो, रुख, पात सबै उडाएर लैजान सक्छ । मान्छेको मगजमा सबभन्दा पहिला आएर ठोक्किने, अर्थात उसले अनुभूति गर्ने पहिलो कडीनै यो परिवर्तन हो । परिवर्तनको एउटा मौलिक विशेषता पनि छ, त्यो हो– परिवर्तनको क्रममा कहिल्यै पुरानो कुरा जस्ताको तस्तै नदोहोरिदैने । त्यसमा पनि परिवर्तन हुन्छ । भनिन्छ– "बाघको खोला फर्कदैन', एउटा नदीलाई दुईपल्ट तर्न सकिदैन" । वास्तवमा कुरा ठीक हो । तर तपाईं सोध्नु होला– दिन र रात त दोहरिरहन्छन् ऋतुहरू, वर्षहरू, पनि दोहरीरह-छन् नी त ? हो, कुनै हदसम्म तपाईंको भनाइमा सत्यता छ; तर के हिजोको दिन र आजको दिन ठ्याम्मै उस्तै छ र ? अवश्य पनि छैन । भनौं हिजो कुनै नजन्मेको हुनसक्छ, भने आज कुनै जन्मिसकेको हुनसक्छ ।

बुद्धि भएको मान्छेले सबभन्दा पहिले यो परिवर्तनलाई बुझ्ने कोशिश गऱ्यो, आँखाले कोशिस गऱ्यो । फलस्वरूप जन्मिए यी हाम्रा घडीहरू, पात्रोहरू इतिहासहरू । उसले नयाँ कुरा बुझ्यो– समय । त्यसोभए समय भनेको के हो त ? समय पदार्थको अस्तित्वको एउटा लक्षण हो, रूप हो । कुनै घटना कस्तो क्रममा घटयो (कुन पहिले, कुन पछि) भनी बुझ्नलाई समयको आवश्यकता पर्छ । समयले परिवर्तन जनाउँछ । त्यसैले परिवर्तनको नियम अनुसार समय कहिले पनि पछि फर्कदैन । तपाईं सोध्नु होला, यो सब गन्थनको भौगर्भिक पात्रोसंग के सम्बन्ध छ त ? आउनु हाँस अब यसैबारे छलफल गरौं ।

माथि भने झैं यदि संसारका सबै कुरा परिवर्तनशील छन् भने किन त्यो घर पछाडिको बडेमानको हुङ्गो जस्ताको तस्तै छ त आजसम्म ? किन बारीको काली माटो कहिल्यै रातो भएन ? किन त्यो महाभारत लेक झिङ्गे अडिरावेको छ आफ्नै ठाउँमा ? तपाईंले यस्ता प्रश्न सोधी मलाई अँठ्यारोमा भने ठान्नु भएको होला, तर हतार नगर्नोस् यसको जवाफ पनि म दिन्छु ।

पत्याउनोस् नपत्याउनोस् हाम्रो धर्मशास्त्र अनुसार पृथ्वी विष्णु भगवानले बनाएको हो रे । अर्को कुरा, भगवान्ले ती कुराहरू नबनाउन्जेल त तिनीहरू छैनै

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थिएन् हैन र ? भए पनि अर्को ठाउँमा फिर्ए होलान् । कस्तो लाग्दो तपाईलाई मेरो तर्क ? अवश्य पनि यो वैज्ञानिक जमानामा यस्तो कुरा के पत्याउनु भन्तु होला तपाई ।

ओं, कुरा विज्ञानमा आएर अड्यो । वास्तवमा विज्ञान र अविज्ञानमा केही फरक त हुनै पर्छ । फरक यत्ति हो– विज्ञानले सबै कुरा अनुभव र प्रयोगको कसीमा जाँच्छ, दाँज्छ, तर्कसंगत र हाम्रा इन्द्रियहरूले अनुभूति गर्न सक्ने, तुरुन्त सक्ने तथ्य र घटनामा मात्र विश्वास गर्छ । उदाहरणको निम्ति हामी यही भूगर्भ शास्त्रलाई लिउँ । भूगर्भशास्त्र पनि एउटा विज्ञान भएकोले यसमा पुराण र परिकल्पनाको कुनै स्थान छैन । कुनै पनि विज्ञानको आफ्नो एउटा विषयवस्तु (*Subject matter*) र आफ्नै एउटा वैज्ञानिक तरिका (*Scientific method*) भए झैं भूगर्भ शास्त्रको विषयवस्तु पृथ्वी हो र यसका चट्टानहरूको अध्ययन र विश्लेषण गर्ने वैज्ञानिक तरिका चाहीं भौगर्भिक पात्रोको आधारमा चट्टानहरूको अन्तर सम्बन्ध तथा उमेर किटान गर्नु हो । तपाईं भन्तु होला, यो त बडो अनौठो मान्छे रहेछ । भौगर्भिक पात्रोले उमेर किटान गर्ने कुरा गर्छ तर पात्रोको भने कुरै गर्दैन । वास्तवमा भन्ने हो भने, भौगर्भिक पात्रो हाम्रो वर्ष वर्षमा निस्कने पात्रो जस्तो हैन । यो बडो अचम्मको पात्रो छ र पात्रो कसरी बन्यो भन्ने बारे पनि रमाइलो इतिहास छ ।

आज भन्दा करिब ४००० वर्ष अघि ग्रीक दार्शनिक अरिस्टोटलले नदी तथा समुद्रको पीँधमा माटो, बालुवा, ढुङ्गा र जीव–जन्तुका अवशेषहरू भएको तह-तह परी जम्मा भएको देखी सबभन्दा तल्लो तहको चट्टान यस्तो माथि बनेको चट्टान भन्दा पुरानो हुनुपर्छ भन्ने नियम प्रतिपादन गरे । यहींबाटनै भौगर्भिक पात्रोको थालनी हुन्छ । महान कलाकार र वैज्ञानिक लियोनार्दो दा भिन्सिले खेत-बारीमा देखिने सीपी, ह्वेलफिस तथा अन्य सामुद्रिक जन्तुहरूको अवशेषलाई हेर्दा यहाँ पनि पहिला समुद्र थियो र यसरी अहिले जमीन भएको ठाउँमा अहिले समुद्र तथा अहिले समुद्र भएको ठाउँमा अहिले जमीन थियो भन्ने नियम पत्तालगाए । त्यस पछि फ्रान्सका बोमेट डे ब्युफन नाम गरेका वैज्ञानिकले यस्तो प्रयोग गरे– एउटा फलामको गोलोलाई उनीले आगोमा पैसरी तताए र पछि चीसो हुन दिए । अनी त्यो गोलो चीसो हुन लाग्ने समयको उनले हिसाब गरे । हाम्रो पृथ्वी पनि पहिले तातो गोलो भएको अनुमान गरी, त्यति ठूलो तातिएको गोलो चीसो हुन कति समय लाग्ला भनी हिसाब गर्दा करिब ७५ हजार वर्ष पो आयो ! तर बाइबल अनुसार ईश्वरले संसार बनाएको जम्मा छ हजार वर्ष मात्र भएको बुझिन्छ । पृथ्वीको उमेर पत्तालगाउन गरिएको यो पहिलो वैज्ञानिक प्रयोग थियो । १९ औं सताब्दिको सुरुतिर लेमार्क र त्यसपछि डार्विनले प्राणीको विकासको सिद्धान्त प्रतिपादित गरेपछि भूगर्भशास्त्रको झन तीव्र गतिमा विकास हुन थाल्यो । अचेल रेडियोधर्मी तत्वहरूको विखण्डनको आधारमा पृथ्वीको उमेर साढे चार अरब वर्ष जति भयो भन्ने ज्ञात भएको छ ।

अहिलेसम्म पृथ्वीको अनुहार कैयौं पल्ट बदलिइसकेको हुनुपर्छ । यो परिवर्तन एक दुई दिन अथवा वर्षमा पनि हुने हैन । यहाँ त कुनै पुराको रूप बदलिन लाखौं लाख वर्ष लाग्न सक्छन् । तपाईंको बारीको ढुङ्गाकै कुरा गरौं: दस बीस लाख वर्ष पहिला, हुन-

सक्छ त्यो दुङ्गाले बनेको थिएन होला र त्यो ठाउँमा समुद्रका छालाहरू गडीखेल्ने होलान् । पछि त्यहाँ बालुवा थिग्रिंदो होला र माटो भए पछि त्यसबाट दुङ्गो बन्दो होला । तबाई भन्नु होला, यी सब कुरा-हरू कसरी थाहा पाउने ? बल्ल अब तबाई र मेरो कुरा मिले । यी सबै कुराहरूको अध्ययन गर्ने विज्ञान-लाई ऐतिहासिक भूगर्भशास्त्र (*Historical Geology*) भनिछन् । अब त्यसैतिर लागौं ।

माथि भनिए झैं ऐतिहासिक भूगर्भशास्त्रको मुख्य वैज्ञानिक तरिका पनि भौगर्भिक पात्रोमा आधारित छ । यो पात्रोमा हाम्रा वर्ष, महिना र दिनहरू झैं विभिन्न इकाईमा समय विभाजन गरिएको छ । सब भन्दा ठूलो समयको इकाईलाई एरा (*Era*, भनिन्छ । पृथ्वीका चट्टानको उमेरको हिसाबले तिनीहरूलाई क्रमशः आर्कियन (*Archean*) प्रोटेरोजोइक (*Proterozoic*) पेलिओजोइक (*Paleozoic*) मेसोजोइक (*Mesozoic*) र सेनोजोइक (*Cenozoic*) एराहरूमा विभाजन गरिएको छ । ती मध्ये सबभन्दा पुरानो एरा आर्कियन हो र सबभन्दा नयाँ चाहीं सेनोजोइक हो । 'आर्कियन' भन्नाले अत्यन्त पुरानो भन्ने बुझिन्छ, त्यसैगरी 'प्रोटेरोजोइक' भन्नाले मिश्र स्तरीय जीवन, 'पेलिओजोइक' भन्नाले पुरानो जीवन, 'मेसोजोइक' भन्नाले बीचको जीवन र 'सेनोजोइक' भन्नाले नयाँ जीवन भन्ने बुझाउँछन् ।

आर्कियन र प्रोटेरोजोइक बाहेक बाँकिल्ला एराहरूलाई 'पीरियड' मा (*Period*) विभाजन गरिएको छ । पेलिओजोइक एराका क्रमशः क्याम्ब्रियन (*Cambrian*), अर्डोभिसियन (*Ordovician*) सिलुरियन (*Silurian*) (वेल्सका पुराना जातिहरूको नामबाट), डेभोनियन (*Devonian*, (इङ्गल्याण्डको डेभोनशीर भन्ने ठाउँबाट), कार्बोनिफेरस (*Carboniferous*) कोइला बढी पाइने क्वाकोजे र पर्मियन (*Permian*) रुसको जिल्लाको नामबाट भन्ने पीरियडहरू छन् । त्यस पछि आउने मेसोजोइक एराका ट्रायासिक (*Triassic*) तीनभाग भएको, जुरासिक (*Jurassic*) फ्रान्स र स्वीटजरल्याण्डको सिमानामा पर्ने पहाडको नामबाट र क्रिटेसियस (*Cretaceous*) ल्याटीन भाषामा खरीको नामबाट पीरियडहरू छन् । अनि सबभन्दा पछिल्लो सेनोजोइक एराका क्रमशः पेलिओसेन (*Paleogene*) पुरानो जीवन, निओजेन (*Neogene*) नयाँ जीवन र क्वाटर्नरी (*Quaternary*) भन्ने पीरियडहरू छुट्याइएका छन् ।

कहिले काहीं पेलिओजेन र निओजेनलाई टर्शरीको (*Tertiary*) नाममा पनि प्रयोग गरिन्छ । एरा तथा पीरियडलाई क्रमशः वर्ष र महिना झैं भन्दा पाँच हप्ता र दिन खोई त ? हो, भौगर्भिक पात्रोमा पनि 'हप्ता' र 'दिन' छन् । अर्थात प्रत्येक पीरियडलाई एपोक(*epoch*)र एपोकलाई एज (*Age*)मा विभाजन गरिएको छ । तर अहिले त्यति गहिरिएर नजाऔं ।

यी पात्रोको अर्को एउटा विशेषता के छ भने, यी एरा, पीरियड इत्यादिहरूले एकातर्फ निरपेक्ष समय (*Absolute time*) देखाउँछन् भने, अर्कोतिर सापेक्ष समय (*Relative time*) बुझाउनु पर्दा एरा अथवा पीरियडको नामले बुझाउँछ । सापेक्ष समय पत्तालगाउनलाई विभिन्न चट्टानहरूमा पाइने अवशेषहरू (*Fossils*) को प्रयोग गरिन्छ भने निरपेक्ष समय पत्तालगाउँदा त्यही चट्टानमा पाइने रेडियो धर्मी तत्वहरूको प्रयोग गरिन्छ ।

अब आउनुहोस् यही पात्रो अनुसार हाम्रो पृथ्वीको प्राणीजगतको उत्पत्ति र विकासबारे छलफल गरौं । एकछिनको निम्ति साढेचार अरब वर्ष पुरानो पृथ्वीलाई ४५ वर्ष भन्ने मानेमा हामी ४ मंजिलो पर्ख ।

पृथ्वी आफ्नो बाल्यावस्थामा(१०–१२ वर्षको हुँदा) निकै तातो थियो र यहाँ क्षण-क्षणमा

भौगर्भिक पात्रो (Geological Time-scale)

समय: दशलाख वर्षमा (*in million years*)

एरा (*Era*)	पीरियड (*Period*)	पहिले	अवधि	प्राणिजगत्को विकासमा महत्त्वपूर्ण घटनाहरू
सेनोजोइक (*Cenozoic*)	क्वाटर्नरी (*Quaternary*)	२	२	आधुनिक मानवको विकास पाषाणयुगी (*Stoneage man*) मानवको विकास
	निओजेन (*Neogene*)	२७	२५	फुलफुल्ने वनस्पतिहरूको विकास । हात्ती, घोडा-हरूको विकास, मान्छेका पूर्वजहरूको विकास ।
	पेलिओजेन (*Paleogene*)	७२	४५	स्तनधारी जन्तु (*Mammals*) हरूको आरम्भिक विकास (हात्ती, घोडाहरूका पुर्खाहरूको विकास)
मेसोजोइक (*Mesozoic*)	क्रिटेसिएस (*Cretaceous*)	१४२	७०	डाइनोसोरसको अन्त्य, एमोनाइटसको अन्त्य ।
	जुरासिक (*Jurassic*)	१८७	४५	चराहरूको सुरुवात (*Flying reptiles*) *Dinosaurs* को चरम विकास ।
	ट्राय-सिक (*Triassic*)	२२७	४०	स्तनधारी (*Mammals*) जन्तुहरूको सुरुवात, आमोनाइट (*Ammonites*) को चरम विकास ।
पेलिओजोइक (*Paleozoic*)	पर्मिएन (*Permian*)	२७२	४५	धेरैने जन्तुहरू (*Reptiles*) को विकास ।
	कार्बोनिफेरस (*Carboniferous*)	३२२	५०	घनाजङ्गल; उभयचर प्राणिहरूको (*Amphibians*) विकास ।
	डेभोनिएन (*Devonian*)	४०२	८०	उभयचर प्राणिहरू (*amphibians*) को सुरुवात र रुखहरूको विकास ।
	सिल्यूरियन (*Silurian*)	४२२	२०	मुगा (*Coral*) र फलफुल्ने वनस्पतिहरूको विकास ।
	अर्डोभिसिएन (*Ordovician*)	४८२	६०	माछा जातिको सुरुवात ।
	क्याम्ब्रिएन (*Cambrian*)	५७२	९०	साधुद्रिक किराहरूको विकास ।
प्रोटेरोजोइक (*Proterozoic*)		१८७२	१३००	प्राणीको उत्पत्ति ।
आर्किएन (*Archean*)		२६७२	८००	

ज्वालामुखी फुटीरहन्थे, भूईचालो आइरहन्थ्यो । क्रमशः पृथ्वी चीसो हुँदै गयो र १५-१६ वर्षको उमेरमा यसको धरातलमा तापक्रम १००° से० भन्दा तल पुगेपछि यहाँ पानी पर्न थाल्यो र सागर तथा महासागरहरू बने ।

पृथ्वी २० वर्षको हुँदा सम्मको इतिहासबारे हामीलाई निकै कम थाहा छ । अफ्रिका, दक्षिण अमेरिका र क्यानाडाका सीमित भागहरूमा पाइने अत्यन्त पुराना चट्टानहरूमा जीव जन्तुहरूको कुनै पनि अवशेष पाइएको छैन । पृथ्वीमा जीवनको शुरूवात पानीबाटनै भएको हो । पहिला अमिबा जस्ता एक कोशिय जीवहरू देखापरे । अनि पृथ्वीको उमेर २५ वर्षको भैसकदासम्म यहाँ खाली ब्याक्टेरिया, काई, लेदु जस्ता निम्नस्तरीय जीवहरू मात्र देखापरे । यो रूप पृथ्वी ३९ वर्ष पुगुन्जेलसम्म चलिरह्यो । पृथ्वी ३९ वर्ष ३ महिनाको भएपछि (क्याम्ब्रीयन पीरियड) जमीनमा क्वार्सचट्टान उम्रनथाले, पानीमा ट्राइलोबाइट (तीन भागमा विभाजित कीरा) र आर्कीओसियाथियन (सोली आकारको किरा)को पनि यहाँ खुबै बोलबाला भयो । यी अंकशेरुकीय (*invertebrate*) जन्तुहरूको विकासको क्रममा पृथ्वी ४० वर्ष र २ महिनाको हुँदा [अर्डोभिसियन पीरियड] यहाँ सर्के किराहरू, घुंगा, दाँत भएका माछा जस्ता जीवहरू पानीमा देखापरे । यी जन्तुहरू अरु सात महिनासम्म [सिलुरियन पीरियड] अरु तीव्र गतिमा बढ्दैगए र पृथ्वी ठयाक्कै ४१ वर्षको हुँदा [डिभोनियन पीरियड] यहाँ जमीन र पानी दुवैमा बस्नसक्ने जन्तुहरू (*Amphibian*) देखापरे । त्यसैबेरी दाह्रे बाख्राहरूको बहलपहल पनि निकै बढ्यो । यता जमीनमा नयाँ, ठूल ठूला पात भएका, घाँसपातहरू तथा कडा जस्ता वनस्पतिहरू पनि बढ्नथाले । अरु ९ महिना पछि [कार्बोनिफेरस पीरियड] हाम्रो पृथ्वीका सबै भागै घरम स्थलमा घनाजङ्गलको विकास भयो । यहाँ सर्वप्रथम फल लाग्ने वनस्पतिहरू देखापरे । पछि पएर यी रुखबाट झरुने कोइलाको रूपलिए । हाम्रो पृथ्वी ४२ वर्ष पुगेर ४ महिना आदा [पर्मिएन पीरियड] यहाँ अहिलेका सर्प र गोहीका पुर्खाहरू देखापरे । अनि क्रमशः अहिलेका किराहरू हराउँदैगए । यो पीरियडमा पृथ्वी निकै गरम थियो । यसरी पेलिओजोईक एराको अन्त्यसम्ममा पृथ्वीमा उभेचरदेखि जन्तुहरू र जमीनमा ठूलाठूला रुख जस्ता घाँसहरूको खूब विकास भैसकेको थियो ।

पृथ्वीको उमेर ४२ वर्ष ९ महिनाको भैसकेपछि [ट्रीयासिक पीरियड] यहाँ पहिला स्तनधारी जन्तुहरू देखापरे । सिलीहरू निकै साना र थोरै थिए । त्यसबेला मालिशाम कीराहरू [*Ammonites*] पनि खूब थिए । त्यसको चार महिना पछि [जुरासिक पीरियड] पृथ्वीभरी गोहि तथा अजिङ्गरका पुर्खाहरू [डाइनोसोरस] अत्यन्त भयानक आकारका भए । यी ठूलठूले जन्तुहरू पानी, जमीन र हावामा पनि बस्न र उड्नसक्ने । सिलीहरूबाटनै अहिलेका चराहरू उत्पत्ति हुन । आजभन्दा डेढवर्ष अघिको कुरा हो, अर्थात पृथ्वी ४३ वर्ष र ७ महिना पुग्दा [क्रिटेसियस पीरियड] हाम्रा औंसा आकारका किराहरू [*Belemnites*], मालिसाम किराहरू र डाइनोसोरसहरू पृथ्वीमा फैलिदैगए । तर अरु छ महिनाभित्र यी जन्तुहरू यहाँबाट क्रमशः हराउँदैगए र यस प्रकार मेसोजोइक एराको पनि अन्त्य भयो ।

सेनोजोइक एराको शुरुवातमा, आजभन्दा ९ महिना अगाडि [पेलिओजेन पीरियड] पहिले देखापरेका स्तनधारी जन्तुहरूको द्रुत गतिले विकास हुन थाल्यो। हात्तीका पुर्खाहरू म्यामोथ र गैंडाहरू पृथ्वीमा देखापरे। ३ महिना अघिको मात्र [नेओजेन पीरियड] कुरा हो यहाँ अहिलेका अस्ता हात्ती, घोडा, हरीण, चराहरू र फूल फुल्ने वनस्पतिहरू तथा हाम्रा पुर्खा– वनमान्छेहरू पनि देखिए।

एक साता अगाडिको कुरा हो [क्वाटर्नरी पीरियड] एउटा वनमान्छेको जाति वनमान्छे जस्तो मान्छेको जातिमा बदलियो। अस्ति बिहान यो वनमान्छे जस्तो मान्छेले पहिलो छुट्टा औजारको रूपमा उठायो। यो जातिलाई होमोसापियनस् [*Homosapians*] भनिन्छ। हिजो मान्छेले आगो पानै सिक्यो। करिब १ घण्टा अगाडि मान्छेहरूले खेती गर्न सिके। करिब १५ मिनेट अघि मात्र सिमीहरूले चोनको पर्खाल र इजीप्टका पीरामीडहरू बनाए। डेढमिनेट अघि मात्र न्यूटनको टाउकोमा स्याऊ खसेको थियो। अनि झण्डै १ मिनेट अघि मात्र मान्छेले पहिलोपल्ट रेलगाडी बनायो। २० सेकेन्ड पनि भएको छैन नील आर्मस्ट्रङ्गले चन्द्रमाको धरातलमा टेकेको।

यसरी औगभिक पात्रोले तपाईलाई पृथ्वीको इतिहासमा एकछिन अल्झाएको नै। जे भए पनि, लाखौं वर्षमा हुने परिवर्तनको क्रममा हाम्रो पृथ्वीको विकासको वैज्ञानिक चित्रण गर्न छोडने यो पात्रो आफ्नै खालको छ। अब औगभिक पात्रोका वर्ष र दिनहरूबाट आफ्नै वर्ष र दिनहरूतिर लागौं कि ?

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